FISH RESEARCH PROJECT OREGON INVESTIGATIONS INTO THE EARLY LIFE HISTORY OF NATURALLY PRODUCED SPRING CHINOOK SALMON IN THE GRANDE RONDE RIVER BASIN

Project Period: 1 June 1993 to 31 May 1994

Annual Report 1994

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OREGON

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ANNUAL REPORT 1994
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EXECUTIVE SUMMARY

Objectives

1. Document the annual in basin migration patterns for spring chinook salmon juveniles in the upper Grande Ronde River, including the abundance of migrants, migration timing, and duration.

2. Estimate and compare survival indices from tagging to smolt recovery at mainstem Columbia and Snake River dams for fall and spring migrating spring chinook salmon.

3. Determine appropriate sampling methods to evaluate winter habitat utilization by spring chinook salmon in the Grande Ronde River basin.

4. Conduct extensive and supplemental spring chinook salmon spawning ground surveys in the Grande Ronde and Imnaha basins to refine methods for estimating escapement. Summarize all spawning ground survey data.

5. Determine age-composition and length-age relationships for spring chinook in each stream surveyed.

6. Determine how adequately historic index area surveys measure trends in spawner abundance by examining year to year variability in the proportions of total redds in a stream that are observed on index surveys.

Accomplishments

We accomplished all of our objectives in 1993. Although we did initiate study of the winter habitat utilized by-spring chinook salmon, river conditions and limited access prevented us from surveying a majority of available habitat.

Findings

Juvenile migrants were observed at the upper Grande Ronde River trap (RK 299) in the fall from 14 September through 5 November 1993 and in the spring from 9 March through 24 June 1994. Fifty percent of all fall migrants had passed the trap by 14 October 1994. Migrants were detected in the Grande Ronde valley section of the river at our trap (RK 164) from 8 October 1993 to 22 June 1994. The date when 50% of all spring migrants had passed the trap was 21 March 1994. A total of 9,369 spring chinook salmon were captured and we estimated that 26,417 migrants passed our upper trap. Approximately 11% of the juvenile migrant population left upper rearing areas in the fall and overwintered in the Grande Ronde Valley habitat. A total of 3,573 migrants were captured in our lower trap and we estimated that 28,225 migrants passed our lower trap.

Spring chinook salmon PIT tagged in the Grande Ronde River were detected at Lower Granite Dam from 21 April to 29 August 1994, with a median passage date of 13 May. Detection rates by tag group ranged from 8.9 to 32.1% with fish tagged during the spring and fall migrations detected at approximately a three times greater rate than fish tagged in summer and winter rearing areas.

We concluded preliminary investigations into the winter habitat utilization of juvenile spring chinook salmon. We surveyed 23 sites and observed only six juvenile salmon. Although snorkeling appeared to be the best method tested, our sampling was limited by turbidity and ice cover. In the future, we will continue to snorkel and will attempt to incorporate methods such as ice breaking and night time observations to increase our sampling opportunities.

During spring chinook salmon spawning ground surveys on the Inmaha River we counted a total of 384 redds on index and extensive surveys and 85 redds on supplemental surveys. We observed 457 redds and a spawning escapement of 1,285 salmon for the entire Imnaha River and 469 redds and 1,3 19 salmon for the mainstem Imnaha basin. In the Grande Ronde River basin we counted a total of 645 redds in index and extensive surveys and 62 redds on supplemental surveys. We estimated a spawning escapement of 1,697 salmon to the Grande Ronde Basin.

We sampled a total of 343 carcasses during the Imanaha River surveys and 399 carcasses during the Grande Ronde River surveys. Information collected from carcasses was used to determine age composition and mean length of spawners. Ages of spawners sampled were predominantly age 4 and 5 with a few age 3 fish found in Catherine and Lookmgglass creeks, and the Imnaha River. The percentage of age 5 spawners ranged from 59% in the Minam River to 100% in Bear Creek.

In 1993, the percentage of redds located in the index areas ranged from 0 to 96 % among the streams surveyed. In five out of seven streams the majority of redds (> 50%) were found within the index survey area. Timing of peak spawning also varied among streams in 1993. A high percentage of redds were observed at the time of index surveys in Catherine Creek and the Wenaha and Grande Ronde rivers. However, few redds were observed at the time of index surveys in the Minam River and Hurricane Creek.

Management Implications and Recommendations

Trapping data from 1993 indicated that a substantial number of juvenile chinook salmon did leave upper river rearing areas in the fall and over-wintered in the Grande Ronde valley habitat between RK 299 and RK 163. We will continue to study fall migrants in future years with the intent to determine specifically what habitat they are utilizing in the valley and to assess the success of this life history strategy based on relative survival to mainstem Snake and Columbia river dams.

INTRODUCTION

The Grande Ronde River originates in the Blue Mountains and flows 334 kilometers to its confluence with the Snake River near Rogersburg, Washington. Historically, the Grande Ronde River produced an abundance of salmonids including spring, summer and fall chinook salmon, sockeye salmon, coho salmon, and summer steelhead (ODFW 1990). During the past century, numerous factors have caused the reduction of salmon populations such that only spring chinook salmon and summer steelhead remain. The sizes of spring chinook salmon populations in the Grande Ronde basin also have been declining steadily and are substantially depressed from estimates of historic levels. It is estimated that prior to the construction of the Columbia and Snake River dams, more than 20,000 adult spring chinook salmon returned to spawn in the Grande Ronde River (ODFW 1990). A spawning escapement of 12,200 adults was estimated for the Grande Ronde in 1957 (USACE 1975). Recent population estimates have been variable year to year, yet remain an order of magnitude lower than historic estimates. In 1992, escapement estimates were 1,022 adults (2.4 X number of redds observed). In addition to a decline in population abundance, a constriction of spring chinook salmon spawning distribution is evident in the Grande Ronde basin. Historically, 21 streams supported spawning chinook salmon, yet today the majority of production is limited to 8 tributary streams and the mainstem upper Grande Ronde River (ODFW 1990).

Numerous factors are thought to contribute to the decline of spring chinook salmon in the Snake River and its tributaries. These factors include passage problems and increased mortality of juvenile and adult migrants at mainstem Columbia and Snake river dams and in reservoirs, overharvest, and habitat degradation associated with land use practices. More than 80% of anadromous fish habitat in the Upper Grande Ronde River is considered to be degraded (USFS 1992). Habitat problems throughout the Grande Ronde River basin (reviewed by Bryson 1993) include poor water quality associated with high sedimentation, poor thermal buffering, moderately to severely degraded habitat, and a decline in abundance of large pool habitat.

Precipitous declines in Snake River spring chinook salmon, including the Grande Ronde River populations, resulted in the listing of the Snake River Evolutionary Significant Unit as endangered under the Endangered Species Act in August 1994. Proposed recovery efforts for Snake River spring chinook salmon require knowledge of population specific life history strategies and critical habitats for spawning, rearing, and downstream migration (Snake River Recovery Team 1993, NWPPC 1992, ODFW 1990). In addition, we need to increase our knowledge of juvenile migration patterns, smolt production and survival, and winter rearing habitat utilization for juvenile spring chinook salmon in the Grande Ronde basin. Both historic and recent estimates of juvenile production in the basin are lacking. However, given the decrease in total number of adult salmon returning to the basin and the extent of habitat degradation, it is reasonable to assume that juvenile production in the basin also has declined. Recent parr-to-smolt survival indices for the Grande Ronde basin range from 12.4-22.1% (Achord et al. 1992, Walters in press). These estimates are based on data from parr that were individually tagged with passive integrated transponders (PIT tags) in early fall and were recaptured at mainstem Columbia and Snake river dams. Therefore, we can not separate out mortality that occurs during the smolt migration from mortality that occurs during the fall and winter prior to the smolt migration.

Nickelson et al. (1992) demonstrated that availability of winter habitat was an important factor limiting coho production in many Oregon coastal streams. Although, typically the chinook salmon smolt migration occurs in the spring, data from Lookingglass Creek (Burck 1974), Catherine Creek, and mainstem Grande Ronde River (pers. comm. D. West, ODFW, LaGrande OR) indicate that some juveniles move out of summer rearing areas during the fall. We know little about the extent of this fall migration.

We are also lacking information on where these fall migrants overwinter. Data from 1993 indicated that 22% of fish that left upper rearing areas overwintered somewhere between the upper (RK 299) and lower (RK 164) traps. Much of the habitat in the mid-reaches of the Grande Ronde River is degraded. Habitat conditions in the section of the Grande Ronde River below La Grande consist of a low gradient meandering and channelized stream which runs through agricultural land. Riparian vegetation in this area is sparse and provides little shade or instream cover. The river is heavily silted due to extensive erosion associated with agricultural and forest management practices and mining activities (USFS 1992). It is reasonable to suggest that salmon overwintering in degraded habitat may be subject to increased mortality due to the limited ability of the habitat to buffer against environmental extremes. If the fall migration from rearing areas constitutes a substantial portion of the juvenile production, then over-wintering habitat may be an important factor influencing spring chinook salmon production in the Grande Ronde basin.

In addition to information on habitats critical for early life stages of chinook salmon, we need to provide information on critical spawning habitat and for monitoring adult populations. Spawning ground surveys provide data on spawning abundance and distribution, sex and age composition of spawners, and origin of spawners. Age composition data is used to develop estimates of brood year production and survival. This information, in turn, is necessary for monitoring population trends used to guide management activities. Information on the distribution and abundance of hatchery strays is also obtained from spawning ground surveys and will help guide hatchery programs in order to minimize impacts to wild populations.

Spring chinook salmon spawning ground surveys have been conducted in selected reaches within spawning areas of streams in the Grande Ronde and Imnaha river basins since the 1950s.

For each spawning stream, both the area surveyed and time of survey were standardized in the 1960s resulting in what have been subsequently called index surveys. Index surveys were the only basis for spawning escapement estimates in the past and are still in use today to monitor trends in spring chinook salmon spawner abundance in Northeast Oregon streams. However, there has been some concern that index surveys do not adequately index current spawner escapement. Changes in the condition of spring chinook habitat, spawner abundance, and origin of spawners have occurred since the index surveys were established over 30 years ago. Thus, one concern is whether or not index surveys provide adequate data to monitor trends in current spawning escapement. In addition, past attempts to develop escapement estimates based on index redd counts have fallen short of our expectations because information on three critical factors needed to expand index redd counts into spawner escapement estimates was scarce or lacking. These factors included the proportion of total redds observed in an index area (spatial expansion), the proportion of total redds that are in the index area that are observed during the index count (temporal expansion), and the relationship between number of redds and fish (fish/redd). Furthermore, given declining trends in Snake River spring chinook salmon populations, escapement estimates for the upper Snake River tributaries need to be more accurate and precise than could be provided by the traditional index surveys.

In 1986, ODFW initiated extensive area and supplemental surveys to measure how well standard index surveys currently index spawner escapement, and to develop more precise estimates of naturally spawning spring chinook salmon. Extensive surveys are conducted on the same day as the index survey and extend the area surveyed beyond the index area to encompass the presumed, total potential area utilized for spawning. Supplemental surveys are conducted within the index area on later dates than the index counts. Results from the extensive and supplemental surveys conducted from 1986-1992 showed that, in most cases, index surveys could not be used to estimate spawner escapement adequately. In the majority of streams sampled, the percentage of redds observed on index surveys varied considerably from year to year. In addition, supplemental surveys showed that the spawning timing was variable year to year and, thus, there was large variation associated with the percentage of redds observed at the time of the index survey. Unless index area surveys can be established that represent a consistent proportion of the total number of redds in the Grande Ronde and Imnaha River basins, extensive and supplemental surveys will need to be conducted so that we can accurately estimate natural spawner escapement.

Goals and Objectives

This study was designed to describe aspects of the life history strategies of spring chinook salmon in the Grande Ronde basin. During the past year we focused on rearing and migration patterns of juveniles and surveys of spawning adults. The specific objectives for the early life history portion of the study were: Obiective 1, document the annual in-basin migration patterns for spring chinook salmon juveniles in the upper Grande Ronde River, including the abundance of migrants, migration timing and duration; Obiective 2, estimate and compare smolt survival indices to mainstem Columbia and Snake River dams for fall and spring migrating spring chinook salmon; Obiective 3 initiate study of the winter habitat utilized by spring chinook salmon in the Grande Ronde River basin. The specific objectives for the spawning ground surveys were: Obiective 4, conduct extensive and supplemental spring chinook salmon spawning ground surveys in spawning streams in the Grande Ronde and Imnaha basin, Obiective 5; determine how adequately historic index area surveys index spawner abundance by comparing index counts to extensive and supplemental redd counts; Obiective 6, determine what changes in index areas and timing of index surveys would improve the accuracy of index surveys; Obiective 7, determine the relationship between number of redds observed and fish escapement for the Grande Ronde and Imnaha river basins.

Methods

Early Life History Study

In Basin Migration Timing aud Abundance

The seasonal migration timing and abundance patterns of juvenile spring chinook salmon in the upper Grande Ronde River was determined by operating juvenile migrant traps from ice-out to ice-up. One rotary screw trap was located below summer rearing areas in the Grande Ronde River (river kilometer ,RK, 299, near the town of Starkey) and another was located in the mainstem of the Grande Ronde River near the town of Elgin (RK 164). A 2.4 m diameter trap, at the lower site, was operated from 8 October to 15 November 1993 and again from 1 February to 31 May 1994. From 16 November 1993 to 3 1 January 1994, a 1.5 m diameter trap was operated at this site due to low flow conditions. A 1.5 m diameter trap was fished at the upper trap site from 13 September to 5 November 1993 and again from 8 March through 31 May 1994. (Note: A ditch was constructed by the state of Oregon in the Grande Ronde Valley in the 1930s. The ditch bypassed 50 kilometers of the natural river channel, decreasing the sinuosity of the river, straightening and shortening the channel. The river now flows approximately 6.4 km in the ditch between RK 240 and RK 190 of the natural channel. The river kilometers we use in this report are based on the natural channel. Thus, a juvenile salmon traveling from the upper trap at RK 299 to our lower trap at RK 163 travels only 92 km.)

The screw traps were equipped with live boxes which safely held hundreds of chinook salmon trapped over a 24 to 72 h trapping time interval. The traps were usually checked daily, but were checked as infrequently as every third day when we were catching only a few fish each day. All juvenile spring chinook salmon were removed from the traps for enumeration, measurement, or interrogation of PIT tags. Prior to sampling, juvenile chinook salmon were anesthetized with MS-222 (40-60 mg/L). Fish were sampled as quickly as possible and were allowed to recover fully before release into the river. We made the assumption that all juveniles captured in these traps were migrating. River height was recorded daily from permanent staff gages.

Trap efficiency tests were conducted with changes in river flow and when there were sufficient numbers of fish available for mark-recapture methodology. Trap efficiencies were determined by releasing known numbers of fin marked juveniles above the traps and determining the number of recaptures within two days of release. We assumed no mortalities were associated with the fin marking procedure used. We estimated the total number of migrants passing each trap by expanding the daily trap catch. Our daily expansion factors were derived from the relationships between gage height and trap efficiency for each trap at each trapping location and when no significant relationship was evident, we simply expanded the daily count based on the seasonal mean trap efficiency for each trap at each trapping location. Consequently we believe our estimates of total migrants to be conservative.

Survival Indices and Migration Timing to Mainstem Dams

PIT tag technology allows for fish to be individually marked and for subsequent observations of marked fish without sacrificing the fish. Therefore, we used data from mainstem observations of PIT-tagged fish to estimate and compare survival among groups of fish that exhibit different life history strategies. Presently, PIT tag monitors are used at four mainstem Columbia and Snake River dams to monitor PIT-tagged fish passage.

Fish that migrate at different times of the year and overwinter in different habitat types are subject to different environmental conditions which can result in variable survival. There is a fall migration from summer rearing areas in the upper Grande Ronde River to areas downstream where fish overwinter and then migrate to the sea the following spring. Other individuals remain in the upper Grande Ronde River through the fall and winter and then begin their seaward migration in the spring. To determine if juveniles that overwintered in different locations exhibited differential survival to mainstem dams, we PIT tagged approximately 500 juvenile spring chinook salmon that were collected in the upper screw trap during the fall, 500 captured withseines above the trap at the end of the fall and 500 at the trap during the spring. We defined the fall migration as downstream movement past our upper trap site between September and December and the spring migration as downstream movement past our upper trap site between February and June. These times encompassed the majority of spring and fall migrations. After the fall migration was finished we collected and PIT tagged approximately 500 juveniles from winter rearing areas upstream of our traps. In addition, 1,000 juvenile spring chinook salmon are PIT-tagged annually in the upper Grande Ronde River as part of a separate study conducted under the Fish Passage Center Smolt Monitoring Program. These fish are tagged as parr in early September and are typically recovered as smolts at mainstem dams. Thus, there were four tag groups for estimating relative smolt survival to mainstem dams. It is important to note that fish tagged in these groups do not necessarily represent unique life history strategies. For example, fish tagged in the summer rearing areas may leave as fall or spring migrants and thus, the summer tagged group contains fish that exhibit rearing and migration strategies identical to all other tag groups.

PIT tagged fish were interrogated upon recapture in screw traps and in bypass systems at mainstem dams. All recaptured fish were identified by their original tag group, thereby insuring independence of tag groups for analysis. Thus, dam recoveries of fish that were tagged in the summer and were recaptured at a river trap in the fall were analyzed as summer tagged fish. Trap-to-trap and trap-to-dam survival indices were estimated using both trap efficiency and the spill over the dams as expansion factors.

We removed fish from each trap live box daily. Each chinook salmon collected was lightly anesthetized and interrogated for a previously implanted PIT tag. We recorded tag numbers and measured lengths and weights of all PIT-tagged recaptures. At the upper trap, we PIT tagged 405 fish in the fall and 573 in the spring that were not previously tagged. In November and early December, after the fall migration was over, we seined and PIT tagged 505 parr from rearing areas above the upper screw trap. After the migration through the Columbia River was completed, we obtained recovery information for PIT-tagged fish recovered at Lower Granite, Little Goose, Lower Monumental, and McNary dams. We determined trap-to-trap and trap-to-dam survival indices for fall and spring migrants and winter-tagged fish, and obtained survival index data from summer-tagged chinook salmon. We compared survival index data among treatment groups. Comparison of survival estimates of fall migrant fish with winter tagged fish will allow us to estimate the relative success of fish that overwinter below the trap with fish that overwinter above. In addition, a comparison of survival estimates for fish tagged as spring migrants versus winter tagged fish allows us to estimate overwintering mortality. Survival estimate data from the summer tagged fish provides information about overall population survival.

Winter Habitat Utilization

We conducted preliminary investigations into the winter habitat utilization of juvenile spring chinook salmon residing in the upper Grande Ronde River basin. We surveyed the Grande Ronde River from RK 299 to RK 163 after the river had frozen to begin to understand the rearing distribution, abundance, and habitat utilization of fish that migrate out of summer rearing areas during the fall. We obtained physical habitat data for RK 167 to RK 297 of the Grande Ronde river. This data was collected by the ODFW Aquatic Inventories project during the summer of 1991. We selected sampling sites based on previous physical habitat surveys and accessibility. Sites were sampled by snorkel observation with two or three persons or by electrofishing with a programmable-pulse, backpack electrofisher. We recorded the fish species present and the following habitat variables: habitat type, area, depth, cover, substrate composition, and water temperature.

Spawning Ground Surveys

Spring chinook spawning ground surveys are conducted from late August to mid September. Specific stream index surveys were originally scheduled to take place following peak spawning. Extensive area surveys cover nearly all possible spring chinook spawning areas and are conducted the day of the index survey. Supplemental surveys are in index areas or in sections of index areas and are conducted twice at approximately one week intervals following the index survey. Surveys are conducted on foot in a downstream direction with one or more surveyors. Surveyors record the number of redds observed (occupied and unoccupied), the number of live adults and jacks observed (on and off redds), and the number of carcasses recovered in the survey sections. Data obtained from each carcass encountered includes; sex, length, fin marks, degree of spawning (females only) and removal of tags. In addition, a sample of 10 scales is removed from each carcass (Nicholas and Van Dyke 1982) and is later used to age fish and for discrimination of hatchery:wild origin. To determine age-composition and age-length relationships scales were mounted on gummed cards and acetate impressions were made using a heat press. Fish age was determined by counting the winter annuli and adding one. Snouts are removed from all adipose fin marked carcasses and recovery and decoding of coded wire tags is conducted by the ODFW CWT Laboratory. The caudal peduncle is severed after the carcass is sampled to avoid repeat sampling on subsequent surveys. On supplemental surveys, redds are numbered and marked with colored flagging. Flagging is removed on the last supplemental survey.

Data from spawning ground surveys are used in estimating chinook escapement. For the majority of systems surveyed the total number of redds observed on surveys is multiplied by a factor of 2.4 fish per redd to estimate total escapement. On the Imnaha River the weir provides the opportunity to utilize mark-recapture methods and estimate the total number of fish above the wier. We next expand the number of total redds observed above the weir to account for increased redds over time in sections surveyed only once based on increases observed in sections surveyed multiple times. These two estimates are used to generate the ratio of fish per redd above the Imnaha Weir. This fish per redd ratio is multiplied by the number of observed redds in the Imnaha River and basin to estimate total escapement using similar methods to that applied to other systems.

Results and Discussion

In Basin Migration Timing and Abundance

The first spring chinook salmon were captured at our upper trap on 14 September 1993, our first day of trapping. We continued to capture fall migrating chinook salmon at this location through ice-up on 5 November 1993. The date when 50% of all fall migrants had passed the trap was 15 October 1993. A total of 2,006 spring chinook salmon were captured at the upper trap during the fall migration. Based on trap efficiency estimates that ranged from to 68 to 86%, we estimated that 2,605 juveniles left the upper Grande Ronde rearing areas in the fall of 1993. Migrants were detected throughout the time the trap was fished (Figure 1).

To better define the migration period and to estimate the number of juveniles migrating, we need to extend our trap fishing season earlier into the summer and, if possible later into December. To accomplish this we plan to move our trap to a suitable site lower in the Upper Grande Ronde River.

We redeployed our upper trap on 8 March 1994 after the majority of the ice had cleared the river. We captured our first spring migrants on 9 March 1994 and continued catching migrants until 22 June 1994. The date when 50% of all spring migrants had passed the trap was 21 March 1994. A total of 7,363 spring chinook salmon were captured at the upper trap during the spring migration. We estimated 23,812 spring chinook salmon left rearing areas of the upper Grande Ronde in the spring of 1994 based on trap efficiencies that ranged from 10 to 58 % .

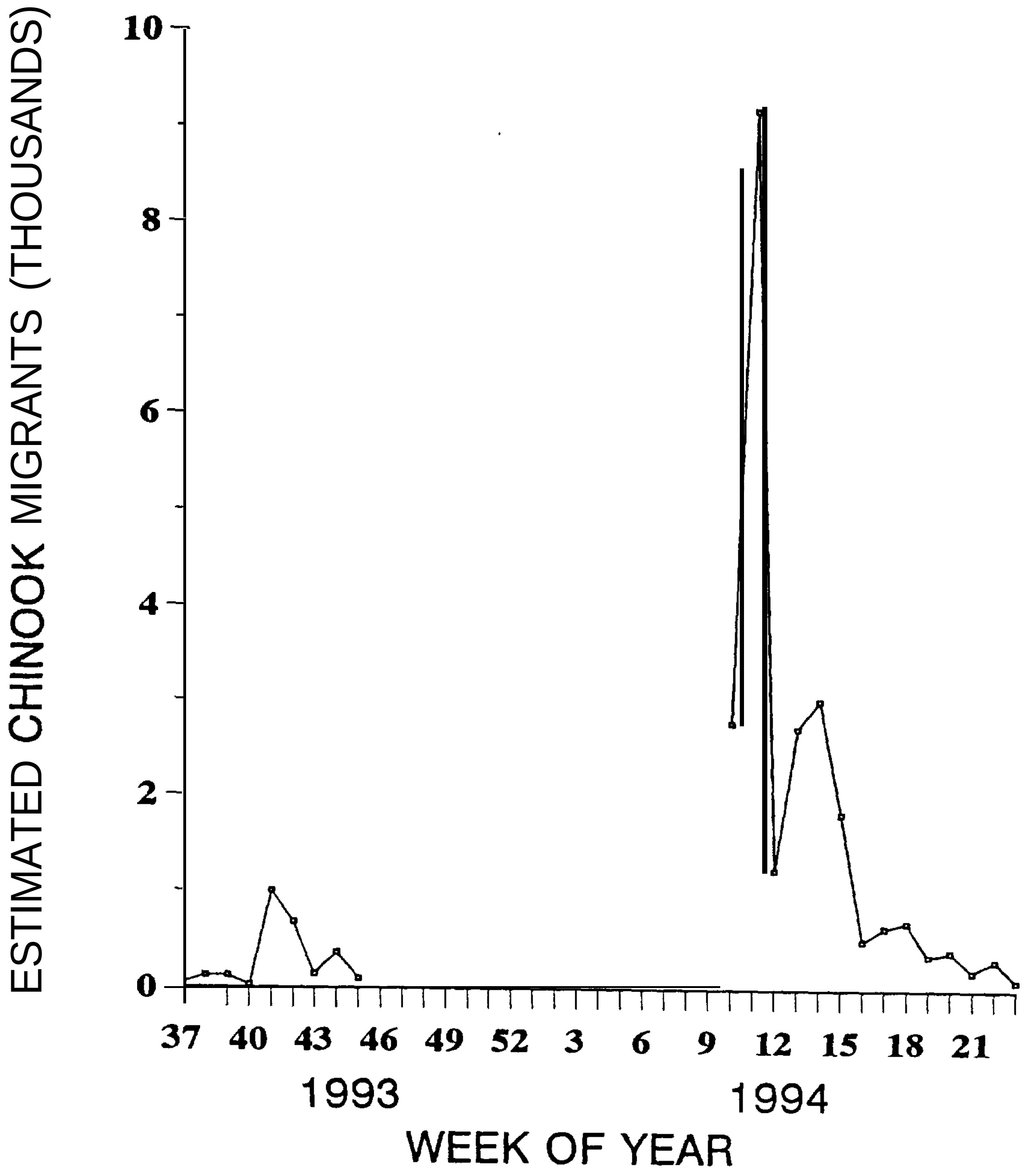

Figure 1. Timing and estimated abundance of juvenile spring chinook salmon migrants captured by a rotary screw trap at RK 299 on the Grande Ronde River, fall 1993 and spring 1994. A total of 2,605 spring chinook salmon were estimated to have migrated in the fall and 23,812 migrated in the spring.

The first spring chinook salmon were captured at our lower trap on 25 October 1993. We continued to capture small numbers of spring chinook salmon at this location through the winter (Figure 2). A total of 3,573 spring chinook salmon were captured at the lower trap from 8 October 1993 to 22 June 1994. We estimated 28,225 spring chinook salmon left the Grande Ronde Valley based on trap efficiency estimates that ranged from 10 to 27 % .

Data from 1993 showed that approximately 11% of the juvenile migrants left upper rearing areas in the fall. This clearly substantiates a fall migration out of rearing areas. Fall downstream movements of juvenile chinook salmon have also been documented in Lookingglass Creek (Burke 1993) within the Grande Ronde basin, in the Lemhi River, Idaho (Bjomn 1971), and in the Warm Springs River, Oregon (Lindsay et al. 1989). Bjomn (1971) found that 50 -70% of the age 0 chinook salmon migrated downstream during fall in the Lemhi River. Lindsay et al. (1989) found that 37 -67% of the spring chinook salmon migrants moved downstream during fall at age 0 in the Warm Springs River. Based on one year of migration data, the proportion of individuals that migrate in the fall from the upper Grande Ronde River appears to be less than that of other populations that have been observed in Oregon. Future trapping data will help clarify if this difference is consistent or if the proportion of the population that migrates in the fall varies from year to year.

We did not observe a fall migration past the lower trap at RK 164. Ninety nine percent of the total fish caught at the lower trap were captured during the spring. These data suggest that the juvenile salmon that left the upper rearing areas overwintered in the upper valley reaches of the Grande Ronde where ‘considerable habitat degradation and stream alteration has occurred. We are planning to survey in the winter to determine the overwintering habitat that is used by fall migrant spring chinook salmon.

We PIT tagged fall and spring migrants captured at our upper trap and juvenile chinook remaining in upper rearing areas after ice-up to estimate survival and migration timing to mainstem dams. Some of these PIT tagged fish were later recaptured at our traps allowing us to obtain information on growth and movement of juveniles within the Grande Ronde River. The mean lengths of juvenile spring chinook salmon captured and PIT tagged are shown in Table 1, and the mean weights of these fish are shown in Table 2. Length frequency distributions of juvenile chinook salmon caught in all three traps are shown in Figure 3. Lengths and weights of migrants by week of the year are shown in Table 3 for the lower trap, Table 4 for the upper trap in the fall, and Table 5 for upper trap in the spring. Weekly averages of length and weight were calculated to see if there was a relationship between fish size and migration time. In the fall at our upper trap we detected a trend for increasing size of migrants over time, as indicated by both increasing fork lengths and increasing weights from week 37 to 45 (Table 4).

When comparing mean lengths of fish from different tag groups at time of tagging we found the mean lengths of fall-tagged fish were larger than the winter-tagged fish by approximately 9 mm fork length, suggesting that the bulk of the fall migration was composed of larger fish moving out of the summer rearing areas. It is interesting to note that when tagged fish from these groups were trapped lower in the river during the spring, the average fork lengths were similar. In spring, fish from the fall-tagged group averaged 0.2 mm larger than fish from the winter-tagged group (Table 6). At our upper trap, the spring migrants were larger, on average, than the fall migrants suggesting greater winter growth in fish that remained in the upper rearing areas during the winter when compared with fish that outmigrated in the fall and over wintered in lower valley habitat. Perhaps movement of larger fish out of rearing habitat allows for compensatory growth in the smaller fish that remain. However, this idea is not supported by growth data from individual fish. Winter-tagged fish that were recaptured at our upper trap in the spring had grown very little during the winter (mean difference = 1.9 mm). One possible explanation for this discrepancy is that the fish we tagged in winter were not representative of all the fish overwintering upstream of our trap. We collected winter residents for tagging from RK 319 to 324. However, there was an 8 km

Table 1. Fork length (mm) of chinook salmon parr collected for an early life history study on the Grande Ronde River for the 1994 migration year. Summer and winter fish were captured with seines in the Grande Ronde River from RK 319 to 326. Fall and spring fish were captured with a rotary screw trap at RK 299. SE = standard error, Min = minimum length, Max = maximum length.

	Collected				
Group	N	Mean	SE	Min	Max
Summer	1,360	60.4	0.20	42	89
Fall	1,473	76.0	0.29	43	115
Winter	529	67.2	0.32	46	86
Spring	2,604	83.0	0.19	57	118

	Tagged and Released				
Release group	N	Mean	SE	Min	Max
Summer	1,001	63.2	0.20	54	89
Fall	402	78.5	0.54	54	115
Winter	505	67.9	0.31	53	86
Spring	573	83.1	0.39	60	109

Table 2. Weight (g) of chinook salmon parr collected for an early life history study on the Grande Ronde River for the 1994 migration year. Summer and winter fish were captured with seines in the Grande Ronde River from RK 319 to 326. Fall and spring fish were captured with a rotary screw trap at RK 299. SE = standard error, Min = minimum weight, Max = maximum weight.

Group	Collected				
	N	Mean	SE	Min	Max
Summer	1,357	2.60	0.027	0.6	7.4
Fall	1,462	5.40	0.058	1.3	14.5
Winter	527	3.59	0.052	1.2	7.2
Spring	2,452	6.42	0.047	2.0	19.5

Release group	Tagged and Released				
	N	Mean	SE	Min	Max
Summer	999	2.94	0.030	1.6	7.4
Fall	395	5.65	0.109	2.3	13.2
Winter	503	3.68	0.051	1.7	7.2
Spring	573	6.47	0.093	2.4	15.3

Table 3. Length (mm) and weight (g) of juvenile spring chinook salmon captured in a rotary screw trap at RK 164 in the Grande Ronde River, week 11 to 24, 1994.

	Length					Weight				
Week	N	Mean	SE	Min	Max	N	Mean	SE	Min	Max
11	47	97.4	1.39	79	126	47	10.01	0.496	5.4	20.8
12	95	99.2	1.03	83	140	88	11.23	0.423	5.5	32.3
13	262	98.1	0.60	70	129	258	10.49	0.220	4.5	24.5
14	109	101.4	1.35	71	136	108	12.13	0.516	4.1	28.1
15	128	106.2	1.18	80	134	128	13.81	0.494	5.3	27.4
16	229	104.2	0.79	77	134	216	13.01	0.302	5.4	26.3
17	39	106.8	1.71	90	128	39	13.86	0.674	7.8	24.6
18	330	105.8	0.58	81	141	329	13.51	0.228	5.4	34.3
19	320	101.9	0.53	79	128	213	12.43	0.238	6.5	22.6
20	282	101.9	0.45	83	131	86	13.08	0.377	6.7	26.4
21	195	100.6	0.65	81	130	52	11.92	0.400	6.9	20.4
22	129	97.5	0.85	54	128	72	10.69	0.306	2.0	18.8
23	43	96.1	1.96	51	115	32	11.85	0.498	3.1	16.2
24	77	96.9	1.33	57	112	77	11.04	0.369	2.4	17.4

Table 4. Length (mm) and weight (g) of juvenile spring chinook salmon captured in a rotary screw trap at RK 299 in the Grande Ronde River, week 37 to 45, 1993.

	Length					Weight				
Week	N	Mean	SE	Min	Max	N	Mean	SE	Min	Max
37	40	72.8	1.47	54	88	36	5.62	0.280	2.0	9.2
38	96	73.1	1.18	43	101	96	4.99	0.203	1.6	10.8
39	117	74.2	1.04	52	98	116	4.61	0.181	1.2	9.3
40	19	77.1	1.75	63	90	19	5.76	0.436	2.5	9.5
41	620	72.3	0.38	49	101	620	4.65	0.070	1.3	11.3
42	221	74.3	0.71	53	99	221	4.97	0.132	1.7	10.9
43	93	84.5	1.06	59	115	89	7.25	0.245	2.6	13.2
44	216	85.8	0.57	61	104	214	7.39	0.142	2.5	14.5
45	51	84.2	1.21	63	100	51	7.02	0.279	2.6	11.5

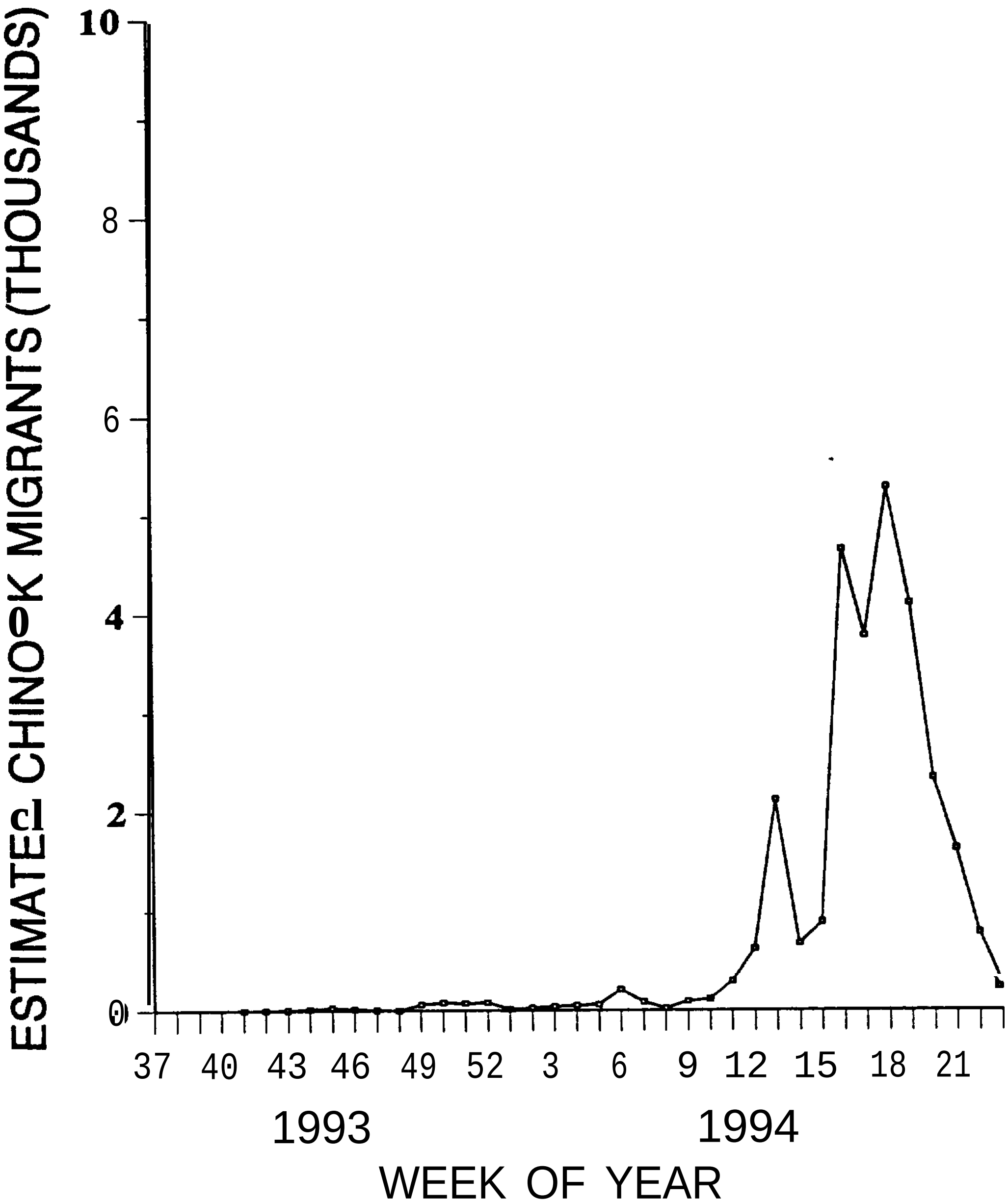

Figure 2. Timing and estimated abundance of juvenile spring chinook salmon migrants captured by a rotary screw trap at RK 164 on the Grande Ronde River, fall 1993 through spring 1994. We estimated that 28,225 spring chinook salmon migrants passed this lower trap.

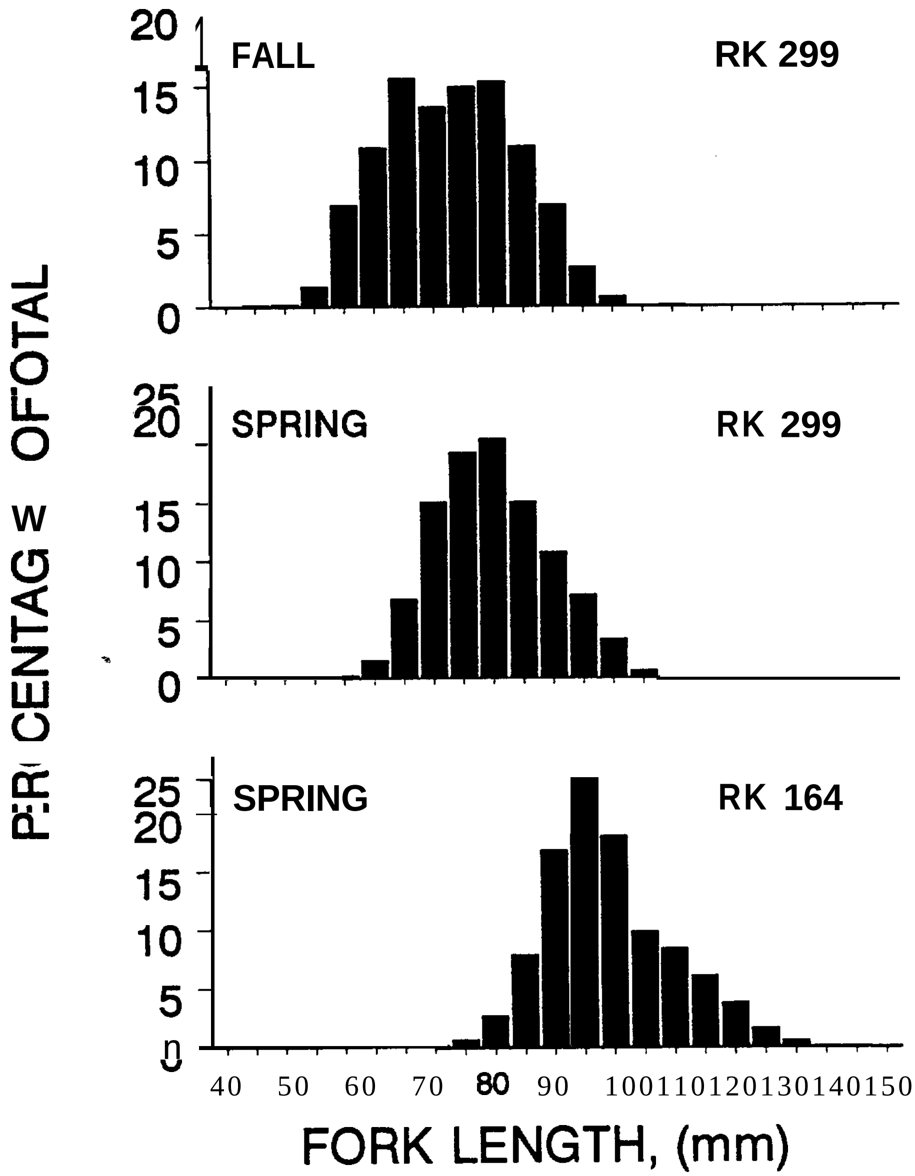

Figure 3. Length frequency (fork length, mm) of juvenile spring chinook salmon migrants captured by rotary screw traps at RK299 and RK164 in the Grande Ronde River, fall 1993 and spring 1994.

Table 5. Length (mm) and weight (g) of juvenile spring chinook salmon captured in a rotary screw trap at RK 299 in the Grande Ronde River, week 10 to 23, 1994.

	Length					Weight				
Week	N	Mean	SE	Min	Max	N	Mean	SE	Min	Max
10	111	91.7	0.75	69	109	111	8.51	0.211	3.0	15.0
11	375	85.3	0.44	65	109	330	6.89	0.115	2.3	13.9
12	247	82.7	0.56	62	108	246	6.03	0.121	2.4	13.4
13	339	83.5	0.49	59	109	339	6.56	0.121	2.3	16.4
14	411	81.3	0.41	57	103	410	5.88	0.090	2.0	11.7
15	331	77.6	0.49	59	107	329	5.11	0.101	2.0	12.9
16	118	84.5	0.91	64	104	118	6.47	0.213	2.8	11.6
17	212	82.3	0.65	64	112	212	6.40	0.164	2.8	14.9
18	193	84.0	0.82	61	118	192	7.01	0.213	2.7	19.2
19	107	87.0	1.07	61	116	102	8.15	0.314	3.1	19.5
20	116	85.8	0.84	61	106	46	7.31	0.300	2.8	11.9
21	34	84.5	1.18	72	97	27	7.68	0.329	4.6	10.7
22	93	86.6	0.88	70	109	72	8.11	0.285	3.9	16.0
23	28	88.5	1.42	75	102	28	8.68	0.392	5.0	13.5

Table 6. Mean fork length of PIT tagged juvenile chinook salmon recaptured in a rotary screw trap in the Grande Ronde River at RK 164, fall 1993 through spring 1994. Standard errors are in parentheses.

		Mean length	
Tag group	N	Tagging	Recapture
Summer	17	64.7 (1.85)	94.1 (2.66)
Fall	18	81.6 (2.54)	96.4 (1.80)
Winter	9	73.3 (1.78)	96.2 (2.89)
Spring	38	84.5 (1.62)	98.3 (1.36)

stretch of habitat on private land that was inaccessible to us during our sampling and has been identified as important juvenile habitat in previous studies. Mean size of winter residents could be substantially different if numerous larger individuals overwinter on this private land. Additional data will be obtained from monitoring in future years to help clarify if the trends seen in 1993 are consistent and biologically significant.

Survival and Migration Timing to Mainstem Dams

The first detection of PIT tagged fish from the upper Grande Ronde was at Lower Granite Dam (LGD) on 21 April 1994. Migrants continued to be detected at LGD until 21 August 1994. The date that 50% of fish passed LGD was 13 May 1994. The majority of the fish were detected at LGD between 22 April and 21 June (Figure 4). These data are consistent with another study in Northeast Oregon that has found the median detection dates of wild spring chinook migrants from the Grande Ronde and Imnaha rivers ranged from early- to mid-May, with peak migrations occurring from the end of April through early May (Walters et al. 1994).

We examined migration timing by individual tag group and found considerable variability (Figure 4). The median migration date by tag group was 29 May for summer, 30 April for fall, 29 May for winter, and 15 May for spring. The earliest tag group detected was the fall group suggesting that fish that overwintered in the Grande Ronde valley moved past the trap earlier than fish from the other tag groups (Figure 5). These fish were similar in size to the other spring migrants when passing our lower trap in the Grande Ronde River (Table 6).

Examining dam detection rates by tag group showed spring migrants to be detected at the highest rate (Table 7). This was expected as the spring migrants are the only tag group that did not suffer overwinter mortality between the time of tagging and the time of recovery at the dams. Two interesting observations were that the fish from the fall tag group were detected at similar rates to fish from the spring tag group and were detected at rates more than three times greater than fish from the winter tag group. Together these results suggest that during 1993 fish that moved out of the upper Grande Ronde rearing areas and overwintered in lower valley habitat survived to the mainstem Columbia dams at a considerably higher rate than fish that remained in Upper Grande Ronde habitat for the winter. These data are too preliminary to draw conclusions about the significance of winter habitat for spring chinook salmon in the Grande Ronde River. We will be examining these relationships in future years to see if results seen in 1993 are consistent over time.

Table 7. First-time detections, as percentage of total fish released, by dam site during the 1994 migration year. Chinook salmon were PIT tagged on the Grande Ronde River during the previous seasons as indicated.

Tag group	Number released	Lower Granite	Little Goose	Lower Monumental	McNary	Total
Summer[a]	1,001	4.4	2.2	1.4	0.9	8.9
Fall	405	16.0	4.9	3.2	2.7	26.9
Winter	505	5.3	2.6	1.4	1.4	10.7
Spring	573	16.2	7.7	3.3	4.9	32.1
TOTAL	2,484	9.2	4.0	2.1	2.2	17.6

[a] *From Walters et al. 1994.*

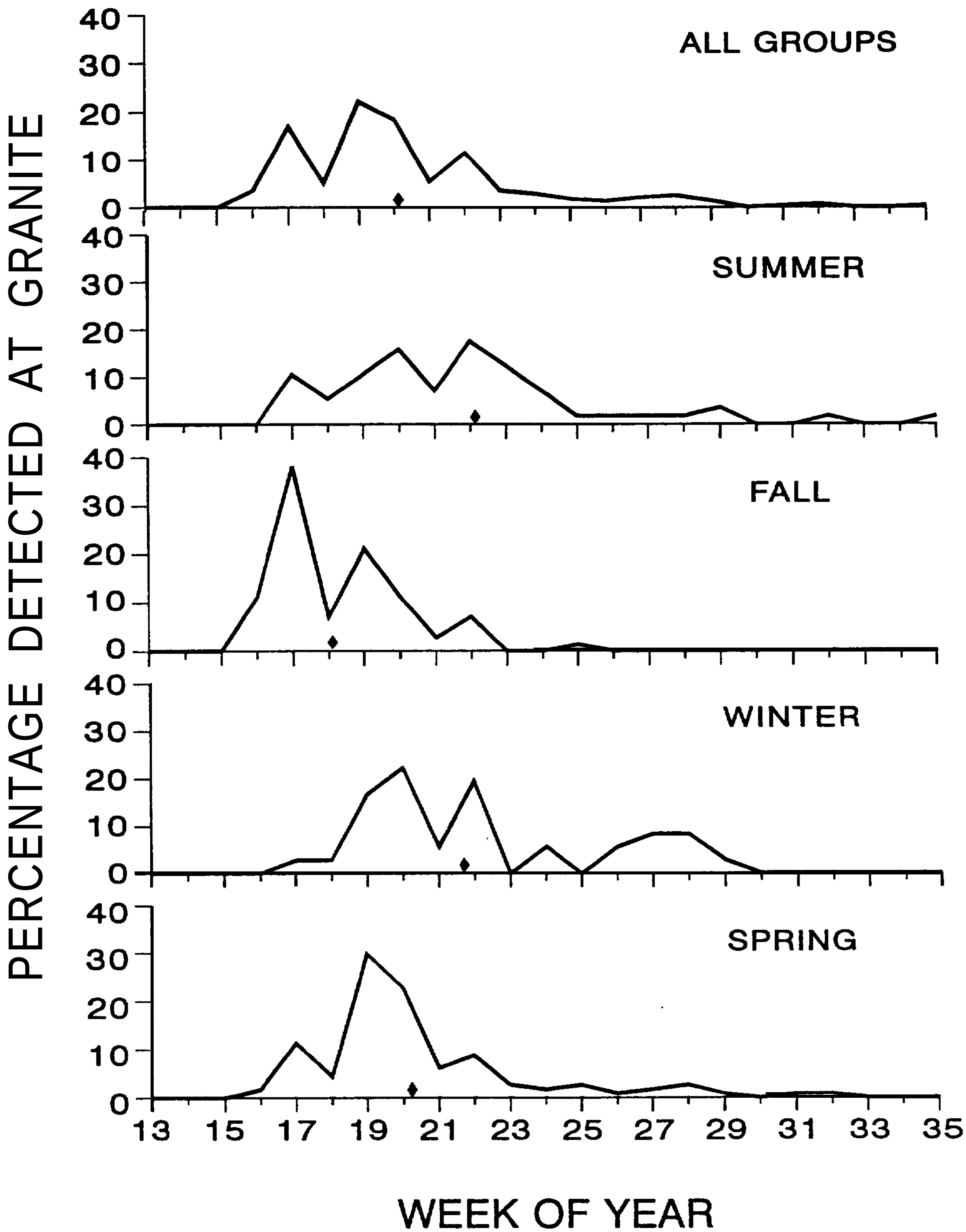

Figure 4. Migration timing at Lower Granite Dam for juvenile spring chinook salmon, by season of PIT tagging, in the Grande Ronde River, 1994 migration year. ♦ = median arrival date. Data were expanded for spillway flow

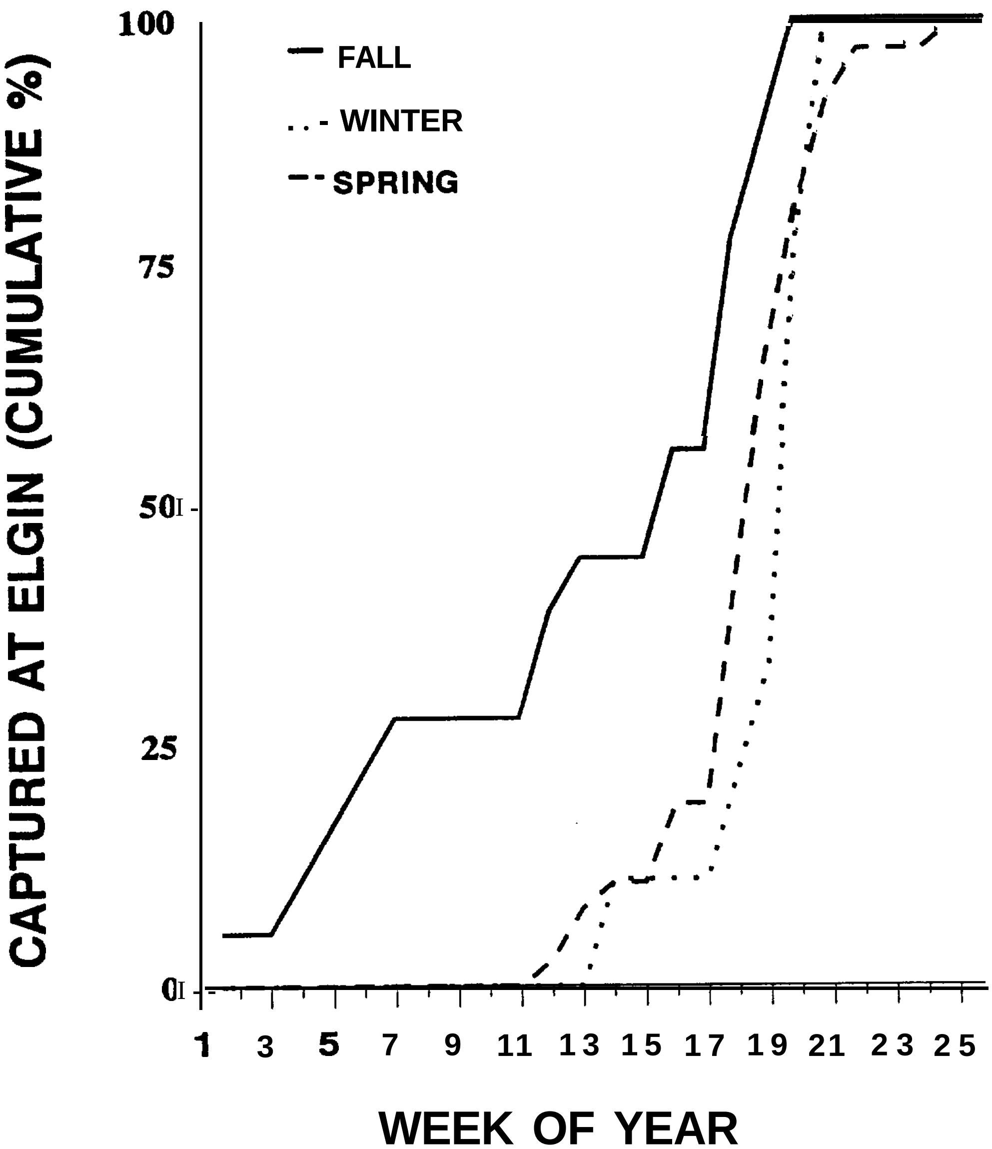

Figure 5. Timing of PIT tagged juvenile spring chinook salmon migrants captured by a rotary screw trap at RK 164 on the Grande Ronde River, 1994, by time of tagging.

Winter Habitat Utilization

The Grande Ronde River, through the Grande Ronde valley (RK 166 to RK 252) is predominantly low gradient (< 0.05 %) glide habitat with substrate composed of sand, gravel, and cobble (Table 8). Habitat upstream of the valley (RK 253) to our upper trap site (RK 299) is a mix of glide, riffle, pool, and rapid habitat with substrate predominantly composed of cobble and gravel and a gradient of 0.4 to 0.7%.

Table 8. Physical habitat availability in the Grande Ronde River from RK 167.3 to 297.0, by river reach. Data were collected by ODFW Aquatic Inventory Project during summer 1991.

	Habitat type (%)				Predominant	Gradient
Reach (RK)	glide	riffle	pool	rapid	substrate[a]	(%)
167.3 - 253.4	96.5	1.8	1.5	0.2	S, G, C	co.05
253.4 - 268.7	29.2	46.6	1.4	22.8	C, G	0.7
268.7 - 288.0	40.0	47.0	5.2	7.8	C, G	0.4
288.0 - 293.4	3.9	38.8	13.0	44.3	C, G, B	0.7
293.6 - 297.0	10.8	47.0	7.5	34.7	C, G	0.7

[a] *Substrate is listed in descending order.*
S = sand, G = gravel, C = cobble, B = bedrock.

From 17 to 23 November 1993, we sampled 23 sites between RK 166 and RK 298 of the Grande Ronde River. We did not observe juvenile chinook salmon in the Grande Ronde valley after ice-up (Table 9). We observed six juvenile chinook salmon upstream of the valley (RK 283.2 to 299) after ice-up. Five of these fish were hiding in the cobble substrate and were collected by electrofishing, and one fish was observed while snorkeling in a pool. Poor visibility and ice cover limited our ability to locate juvenile chinook salmon. This problem was exacerbated in the valley habitat where we were unsuccessful locating chinook due to either heavy ice cover or visibility less than 0.5 m. We plan to explore alternative sampling techniques to locate overwintering salmon in the future.

Spawning Ground Surveys

Spring chinook salmon spawning ground surveys were conducted in Northeast Oregon from 25 August to 16 September 1993 under NMFS ESA Permit No. 818. A total of 147.4 river kilometers (43 kilometers resurveyed during supplemental surveys) were surveyed in the Imnaha Basin. We counted a total of 384 redds on index and extensive counts and 85 redds on supplemental surveys (Table 10). We sampled a total of 345 salmon carcass in the Imnaha basin. We observed 333 redds above the Imnaha River chinook salmon weir and estimated a spawning escapement of 938 salmon based on recapture data from adults marked at the weir. This resulted in a fish/redd ratio of 2.8. Previous estimates of fish/redd in the Imnaha River were 3.2, 2.4, and 4.3 in 1990, 1991, and 1992 respectively. The 1993 escapement estimates were 1,280 salmon for the mainstem Imnaha River and 1,313 salmon for the entire Imnaha basin. This escapement estimate does not include redds from fish outplanted in Lick Creek on 8 September 1993. In the Grande Ronde River basin, we surveyed a total of 320.3 river kilometers (74.6 supplemental survey kilometers) and counted a total 645 redds in index and extensive surveys and 62 redds on supplemental surveys (Table 10). A total of 399 carcasses were sampled in the Grande Ronde

Table 9. Sites surveyed for winter habitat utilization by juvenile chinook salmon and the number of juvenile chinook observed, in the Grande Ronde River during November 1993.

Location (RK)	Habitat type	Sampling method	Chinook observed
167.3	pool	snorkel	0
188.3	pool/glide	snorkel	0
214.0	riffle/pocket pools	snorkel	0
243.0	riffle/pool	snorkel	0
248.6	pool	snorkel	0
253.4	pool/glide	snorkel	0
260.7	pool	snorkel	0
267.1	pool/glide	snorkel	0
267.1	pool/glide	snorkel	0
267.1	pool/glide	electrofish	0
271.9	pool	snorkel	0
274.3	pool/glide	snorkel	0
278.4	pool	snorkel	0
281.6	pool	snorkel	0
283.2	glide	snorkel	0
283.2	glide	electrofish	0
283.2	pool	electrofish	1
288.0	glide	snorkel	0
288.0	riffle/pool/glide	electrofish	0
288.8	pool	snorkel	0
294.4	riffle/pool	electrofish	4
297.7	pocket pools	snorkel	0
299.0	pool	snorkel	1

Table 10. Spring chinook salmon spawning ground surveys in the Imnaha and Grande Ronde river basins, 1993. M = male, F = female, J = jack, U = unknown.

Basin, Stream, Section	Date	Miles	Redds Occupied	Redds Unoccupied	Redds Total	Live Fish On Redds Adults	Live Fish On Redds Jacks	Live Fish Off Redds Adults	Live Fish Off Redds Jacks	Dead Fish M	Dead Fish F	Dead Fish J	Dead Fish U
Imnaha River Basin:													
Lick Creek[a]	08/25	4.0	0	0	0[b]	0	0	0	0	0	0	0	0
Big Sheep Creek													
Bridge to Echo Canyon[a]	08/25	4.0	0	1	1	0	0	0	0	0	0	0	0
Echo Canyon to Carrel Ck	08/25	6.0	0	3	3	0	0	0	0	0	0	0	0
Carrel Creek to Coyote Ck	08/25	3.0	1	2	3	1	0	0	0	0	0	0	0
Coyote Ck to Squaw Ck	08/25	5.0	4	0	4	5	0	0	0	0	0	0	0
Squaw Ck to Muley Ck	08/25	5.5	1	0	1	2	0	0	0	0	0	0	0
Total		23.5	6	6	12	8	0	0	0	0	0	0	0
South Fork Imnaha River													
Soldier Ck.to Forks	08/27	2.0	0	0	0	0	0	0	0	0	0	0	0
Imnaha River[c]													
Forks to Falls	08/27	1.0	0	0	0	0	0	0	0	0	0	0	0
Falls to Blue Hole[d]	08/27	2.5	0	5	5	0	0	0	0	0	0	0	0
Blue Hole to Indian Crossing[a]	08/27	2.0	16	18	34	23	1	6	0	6	14	0	0
Indian Crossing to Mac's Mine[a]	08/27	7.7	60	125	185	77	1	13	0	40	37	0	2
Mac's Mine to Weir	08/27	4.5	17	37	54	21	0	6	0	24	17	2	1
Weir to Crazyman Creek	08/27	3.5	51	28	79	71	0	10	0	9	15	0	0
Crazyman to Grouse Creek[e]	08/27	8.5	5	9	14	8	2	4	0	0	0	0	1
Grouse to Freezeout Creek	08/27	6.0	0	1	1	0	0	0	0	2	0	0	0
Total Imnaha River Drainage		37.7	149	223	372	200	4	39	0	81	83	2	4
Basin Total		65.2	155	229	384	208	4	39	0	81	83	2	4

[a] *Index area.*
[b] *24 redds observed on 09/08/93 after outplanting 16 male and 33 female adults from the Imnaha facility.*
[c] *Does not include carcasses recovered by Nez Perce Tribal biologists.*
[d] *Observed from trail, minimum count.*
[e] *Excludes section from RM 44 to RM 46 because landowner denied access.*

Table 10, continued

Basin, Stream, Section	Date	Miles	Redds Occupied	Redds Unoccupied	Redds Total	Live Fish On Redds Adults	Live Fish On Redds Jacks	Live Fish Off Redds Adults	Live Fish Off Redds Jacks	Dead Fish M	Dead Fish F	Dead Fish J	Dead Fish U
Grande Ronde River Basin:													
Bear Creek													
2 mile reach above G.S.	08/24	2.0	1	8	9	1	0	0	0	1	I	0	0
Guard Station to Bridge[a]	08/24	6.5	1	8	9	1	0	0	0	1	2	0	0
Bridge to diversion	08/24	2.1	0	1	1	0	0	0	0	0	0	0	0
Total		10.6	2	17	19	2	0	0	0	2	3	0	0
Hurricane Creek													
Gravel Pit to mouth[a]	08/23	3.0	8	11	19	9	0	11	0	0	2	0	1
Lostine River													
Lapover Meadow to Williamson Campground	08/28	5.0	1	10	11	2	0	0	0	0	0	0	0
Log Jam to Six-mile Bridge	08/28	2.0	0	0	0	0	0	0	0	0	0	0	0
Six-mile Bridge to OC Ranch Bridge[af]	08/28	3.0	18	48	66	26	0	6	0	7	25	0	0
OC Ranch Bridge to West Side Ditch	08/28	1.6	6	4	10	6	0	3	0	2	4	0	0
West Side Ditch to Lostine	08/28	4.0	2	4	6	2	0	1	0	2	1	0	0
Lostine to McLain's	08/28	2.7	0	0	0	0	0	0	0	0	0	0	0
McLain's to Mouth	08/28	2.7	1	1	2	1	0	0	0	0	0	0	0
Total		21.0	28	67	95	37	0	10	0	11	30	0	0
Wallowa River													
McClarren Lane Bridge to Hatchery intake (a)	08/23	4.5	0	1	1	0	0	3	0	0	0	0	0

[a] *Index area.*
[f] *Includes 4 male and 12 female carcasses sampled on 08/20/93.*

Table 10, continued

Basin, Stream, Section	Date	Miles	Redds: Occupied	Redds: Unoccupied	Redds: Total	Live Fish: On Redds: Adults	Live Fish: On Redds: Jacks	Live Fish: Off Redds: Adults	Live Fish: Off Redds: Jacks	Dead Fish: M	Dead Fish: F	Dead Fish: J	Dead Fish: U
Grande Ronde River Basin, continued													
Grande Ronde River													
Three Penny Claim to Road 5 125 Bridge[a]	09/03	8.5	6	82	88	7	0	2	0	7	14	0	7
Road 5125 Bridge to Starkey Bridge	09/03	13.7	3	1	4	3	2	1	0	5	2	0	0
Total		22.2	9	83	92	10	2	3	0	12	16	0	7
Sheep Creek													
Forks to Road 5182 culvert	09/03	3.0	0	1	1	0	0	0	0	0	0	0	0
Road 5182 culvert to mouth[a]	09/03	6.0	0	0	0	0	0	0	0	0	0	0	0
Total		9.0	0	1	1	0	0	0	0	0	0	0	0
North Fork Catherine Creek													
Middle Fork to mouth[a]	09/02	3.0	1	6	7	1	0	0	0	0	1	0	0
South Fork Catherine Creek													
Road Barrier to start of Index area	09102	0.7	0	0	0	0	0	0	0	0	0	0	0
Index Area[a]	09/02	2.0	0	2	2	0	0	0	0	0	0	0	0
Catherine Creek													
Forks to Badger Flat Road[a]	09/02	7.5	8	46	54	8	0	5	0	9	8	0	0
Badger Flat Road to 2nd Union City Bridge	09/02	7.0	11	8	19	16	0	0	0	2	3	0	0
Total		14.5	19	54	73	24	0	5	0	11	11	0	0
Total Catherine Cr. Drainage		20.2	20	62	82	25	0	5	0	11	12	0	0

[a] *Index area.*

Table 10. continued

Basin, Stream, Section	Date	Miles	Redds: Occupied	Redds: Unoccupied	Redds: Total	Live Fish: On Redds: Adults	Live Fish: On Redds: Jacks	Live Fish: Off Redds: Adults	Live Fish: Off Redds: Jacks	Dead Fish: M	Dead Fish: F	Dead Fish: J	Dead Fish: U
Grande Ronde River Basin, continued													
Indian Creek													
Old index area	09/09	3.0	0	2	2	0	0	0	0	0	1	0	0
Little Lookingglass Cr.[g]	09/10	4.0	0	30	30	0	0	0	0	7	26	0	0
Lookingglass Creekg													
Summer Creek to L. Lookingglass Cr.[a]	09/09	6.2	2	87	89	2	0	0	0	28	49	1	1
L. Lookingglass Cr. to Mouth	09/09	3.8	1	29	30	1	0	2	0	21	25	4	0
Total		10.0	3	116	119	3	0	2	0	49	74	5	1
Lookingglass Drainage Totals		14.0	3	146	149	3	0	2	0	56	100	5	1
Little Minam River													
Old index area	08/26	1.5	1	5	6	1	0	0	0	0	0	0	0
Mouth to start of index	08/26	3.5	4	12	16	4	0	2	0	1	0	0	0
Total		5.0	5	17	22	5	0	2	0	1	0	0	0
Minam River													
Upper Minam[a]	08/24	6.0	9	19	28	9	0	4	0	0	4	0	1
Lower Minam[a]	08/25	7.5	19	16	35	26	0	2	0	8	4	0	1
Total		13.5	28	35	63	35	0	6	0	8	8	0	2
Minam River Drainage Total		18.5	33	52	85	40	0	8	0	9	8	0	2

[a] *Index area.*
[g] *Cumulative redd count and carcass recoveries from multiple surveys conducted by **CTUIR** biologists.*

Table 10, continued

Basin, Stream, Section	Date	Miles	Redds: Occupied	Redds: Unoccupied	Redds: Total	Live Fish: On Redds: Adults	Live Fish: On Redds: Jacks	Live Fish: Off Redds: Adults	Live Fish: Off Redds: Jacks	Dead Fish: M	Dead Fish: F	Dead Fish: J	Dead Fish: U
Grande Ronde River Basin, continued													
North Fork Wenaha River													
Lower 4.0 miles	09/08	4.0	0	4	4	0	0	0	0	0	0	0	0
South Fork Wenaha River													
Above Milk Creek	09/07	0.3	0	0	0	0	0	0	0	0	0	0	0
Milk Creek to Forks[a]	09/07	6.0	8	38	46	8	0	1	0	0	6	0	1
Wenaha River													
Forks to Crooked Creek	09/7-9	15.5	8	40	48	8	0	1	2	7	8	0	0
Wenaha River Tributaries													
Milk Creek	09/07	0.3	0	0	0	0	0	0	0	0	0	0	0
Butte Creek	09/09	1.5	0	2	2	0	0	0	0	1	0	0	0
Total Wenaha River Drainage		27.6	16	84	100	16	0	2	2	8	14	0	1
Basin Total		153.6	119	526	645	142	2	44	2	109	186	5	12

[a] *Index area.*

basin. Based on these redd counts and assuming 2.4 fish per redd (Carmichael and Boyce 1986), we estimated a spawning escapement of 1,697 salmon to the basin. The disruption of spawning salmon observed during the surveys was minimal. Observations made by experienced surveyors indicated that less than one third of the fish encountered exhibited any disturbance and most of these disturbed fish resumed spawning activities in a relatively short time period, usually less than 5 minutes. No fish injuries nor mortaliies occurred during spawning ground surveys.

Information collected from spring chinook carcasses was used to determine age composition, mean length, and sex ratios of spawners (Table 11 and 12). In 1993, the majority of salmon carcasses recovered in the Grande Ronde (74.4%) and Irnnaha (75.5 %) basins were age 5 fish from the 1988 brood. Scale samples from carcasses are being analyzed in order to determine the origin (hatchery or wild) of spawners. Any mark recoveries (radio tags, jaw tags, coded-wire-tags) were processed and information was sent to appropriate agencies.

Spring chinook spawning areas were surveyed on index and extensive surveys (Table 10). In 1993, there was considerable variability in the percentage of redds located in the index areas among the streams surveyed (Table 13). No redds were found on the Sheep Creek index survey, while on the upper Grande Ronde 96 % of all redds were observed on the index survey. In 5 of 7 streams surveyed the majority (> 50%) of the redds were located within the index survey area.

Comparing the 1993 survey data with previous survey results (1986 - 1992) demonstrates interannual variability of the percentage of redds found in index areas among certain streams (Table 14). Big Sheep Creek, Sheep Creek, and the Wenaha River exhibit the greatest variability. The most parsimonious explanation for this variability in Big Sheep and Sheep creeks is extremely low redd numbers. The spring chinook spawning population in Sheep Creek has averaged 12 adults, approximately 4 redds, from 1986-1993. Thus, a small change in distribution results in a large change in the percentage of redds within the index area. We are uncertain what factors are influencing the variability of redd distribution in the Wenaha River. We have speculated about the influx of hatchery strays and water flow and hope to examine the data more closely to see if such a relationship exists.

Supplemental surveys were conducted to determine variation in spawning timing and to increase carcass recovery rates (Table 15). We observed a total of 486 live fish and recovered and sampled 744 spring chinook salmon carcasses during surveys. Approximately 9% -of the live fish and 35 % of carcasses were obtained on supplemental surveys. Timing of peak spawning in 1993 was highly variable and was similar to the variation observed from 1986-1992 (Table 5). A high percentage of redds were observed at the time of the index counts in Catherine Creek and the Wenaha and Grande Ronde rivers in 1993 (Table 16). However, few redds were seen at the time of index counts in the Minam River and Hurricane Creek. The increase from the the index survey to the supplemental surveys was 96 % for the Minam River and 108 % for Hurricane Creek. This increase may have been related to a high percentage of hatchery fish entering these systems later than native fish. In addition, variation in spawning timing may reflect losses in segments of the spawning population due to significantly reduced population levels. Spawning timing may also be affected by environmental variables such as river flow and water temperature.

There is substantial intra- and interannual variability in spawning timing and the distribution of redds in several of the rivers we surveyed. Given this variability and the low predicted salmon returns for the next few years, we will continue to conduct index, extensive, and supplemental surveys. We also will attempt to examine if a relationship exists between spawning timing, river flows, and water temperatures. This information will assist us in evaluating the utility of index surveys and, in the meantime, will allow us to more accurately estimate spring chinook salmon escapement to the Grande Ronde and Imnaha River basins.

Table 11. Percent age composition of spring chinook salmon carcasses sampled on spawning ground surveys in some NE Oregon streams, 1993. Age nomenclature is that of Gilbert and Rich (1927).

Basin, Stream	N	Age 3_2	Age 4_2	Age 5_2
Imnaha River Basin				
Lick Creek[a]	31	0.0	22.6	77.4
Big Sheep Creek	0	0.0	0.0	0.0
Imnaha River[b]	521	1.4	23.2	75.4
Basin Average		1.3	23.2	75.5
Grande Ronde River Basin				
Bear Creek	5	0.0	0.0	100.0
Hurricane Creek	10	0.0	10.0	90.0
Lostine River	74	0.0	21.6	78.4
Grande Ronde River	46	0.0	6.5	93.5
Catherine Creek	28	7.1	7.1	85.8
Lookingglass Creek[c]	154	3.2	28.6	68.2
Minam River	44	0.0	40.9	59.1
Wenaha River	29	0.0	27.6	72.4
Indian Creek	1	0.0	0.0	100.0
Basin Average		1.8	23.8	74.4

[a] *Outplanted from Imnaha River weir returns.*
[b] *Includes samples from carcasses found washed up on Imnaha weir.*
[c] *Includes adults outplanted from Lookingglass Hatchery and weir recoveries.*

Table 12. Mean fork length (mm) for age specific groups of adult spring chinook salmon sampled on spawning ground surveys in some NE Oregon streams, 1993. Age nomenclature is that of Gilbert and Rich (1927). Standard deviation is shown in parenthesis.

	Age 3_2				Age 4_2				Age 5_2			
	Males		Females		Males		Females		Males		Females	
Stream	N	Length	N	Length	N	Length	N	Length	N	Length	N	Length
Big Sheep Creek	0	--	0	--	0	--	0	--	0	--	0	
Lick Creek[a]	0	--	0	--	2	782(53)	5	824(25)	6	1008(44)	18	902(41)
Imnaha River[b]	7	527(47)	0	--	62	770(85)	56	783(48)	160	978(66)	226	912(42)
Hurricane Creek	0	--	0	--	0	--	1	700	1	915	8,	839(79)
Bear Creek	0	--	0	--	0	--	0		1	782	2	782(11)
Indian Creek	0	--	0	--	0	--	1	810	0	--	0	--
Grande Ronde River	0	--	0	--	0	--	3	747(32)	15	893(32)	28	838(35)
Catherine Creek	2	610(14)	0	--	1	680	1	730	11	903(52)	13	865(41)
Lookingglass Creek[c]	5	510(58)	0	--	11	763(32)	31	725(41)	39	901(65)	66	838(36)
Minam River	0	--	0	--	7	760(32)	11	690(42)	11	888(67)	15	857(36)
Wenaha River	0	--	0	--	2	735(92)	6	710(42)	5	936(47)	15	834(35)

[a] *Outplants from Imnaha River weir returns.*
[b] *Includes carcasses found washed up on the Imnaha weir.*
[c] *Includes outplants from Lookingglass Hatchery returns.*

Table 13. Comparison of index area and extended area spring chinook salmon spawning ground surveys in some Imnaha and Grande Ronde river basin streams, 1993.

Basin, Stream	Date	Miles Surveyed Inside Index	Miles Surveyed Outside Index	Redds Inside Jndex	Redds Outside Index	Live Fish Inside Index	Live Fish Outside Index	Dead Fish Inside Index	Dead Fish Outside Index	% redds in index area
Imnaha River Basin:										
Big Sheep Creek	08/25	4.0	19.5	1	11	0	8	0	0	8
Imnaha River	08/28	9.7	25.5	219	153	121	122	99	71	59
Grande Ronde River Basin:										
Lostine River	08/28	3.0	18.0	66	29	32	15	32	9	69
Sheep Creek	09/03	6.0	3.0	0	1	0	0	0	0	0
Catherine Creek	09/02	7.5	7.0	54	19	13	16	15	5	74
Wenaha River[a]	09107-09	6.0	15.5[b]	46	48	9	11	7	15	49
Grande Ronde River	09/03	8.5	13.7	88	4	9	6	28	7	96
Bear Creek	08/24	6.5	4.1	9	10	1	1	3	2	47

[a] *South Fork Wenaha River.*
[b] *Forks to Crooked Creek, does not include North Fork or mainstem tributaries.*

Table 14. Percentage of spring chinook salmon redds observed in index areas on the day of the index survey in some Imnaha and Grande Ronde basin streams, 1986-1993.

Stream	Percent of redds observed in index area								
	1986	1987	1988	1989	1990	1991	1992	1993	Mean(95 % CI)
Imnaha Basin:									
Big Sheep Creek	60	19	100	50	0	17	0	8	31.8(29.8)
Imnaha River	77	80	78	56	75	55	64	59	68.0(8.8)
Grande Ronde Basin:									
Lostine River	79	72	65	80	84	55	64	69	71.0(8.0)
Grande Ronde River	77	73	95	--	100	100	99	96	91.4(10.5)
Sheep Creek	67	78	0	0	0	--	71	0	30.9(35.7)
Catherine Creek	81	69	75	89	90	100	97	74	85.9(9.5)
Wenaha River	--	41	60	50	40	51	35	49	46.6(7.8)

Table 15. Comparison of spawning ground counts conducted at the standard index survey time, and twice after the index survey on some Imnaha and Grande Ronde river basin streams, 1993. Areas surveyed are index areas or within index areas. Percent change represents change from index to third survey.

Basin, Stream, Section	Date	Miles	Redds			Live Fish				Dead Fish	
						On Redds		Off Redds			
			Occupied	Unoccupied	Total	Adults	Jacks	Adults	Jacks	Adults	Jacks
lmnaha River Basin:											
Imnaha River	08/27	7.7	60	125	185	77	1	13	0	79	0
Indian Crossing to	09/07	7.7	6	194	200	6	0	0	0	36	1
Mac's Mine	09/14	7.7	1	211	212	1	0	0	0	9	0
Percent Change					+15						
Mac's Mine to	08/27	4.5	17	37	54	21	0	6	0	41	2
Weir[a]	09/14	4.5	0	82	82	0	0	0	0	40	2
Percent Change					+52						
Imnaha River	08/27	3.5	51	28	79	71	0	10	0	14	0
Weir to	09/07	3.5	20	85	105	7	0	0	0	58	0
Crazyman Creek	09/14	3.5	0	109	109	0	0	1	0	25	2
Percent Change					+38						
Grande Ronde River Basin:											
Lostine River	08/28	3.0	18	48	66	26	0	6	0	32	0
'Six-mile Bridge to	09/04	3.0	5	68	73	6	0	1	0	17	0
OC Ranch Bridge	09/13	3.0	0	73	73	0	0	1	0	8	0
Percent Change					+11						
Grande Ronde River	09/03	3.5	3	46	49	3	0	2	0	19	0
3-Penny Claim to	09/10	3.5	0	55	55	0	0	1	0	4	0
Forest Boundary	09/16	3.5	0	56	56	0	0	0	0	3	0
Percent Change					+14						
Grande Ronde River	09/03	5.0	3	36	39	4	0	0	0	9	0
Forest Boundary to	09/10	5.0	0	43	43	0	0	0	0	0	0
Road 5 125 Bridge	09/16	5.0	0	43	43	0	0	0	0	0	0
Percent Change					+10						

[a] *Only one supplemental survey conducted.*

Table 15 continued.

Basin, Stream, Section	Date	Miles	Redds: Occupied	Redds: Unoccupied	Redds: Total	Live Fish, On Redds: Adults	Live Fish, On Redds: Jacks	Live Fish, Off Redds: Adults	Live Fish, Off Redds: Jacks	Dead Fish: Adults	Dead Fish: Jacks
Grande Ronde River Basin, continued											
Hurricane Creek	08/23	1.3	5	7	12	5	0	5	0	2	0
Gravel Pit to	09/02	1.3	4	19	23	4	0	2	0	7	0
McCorman Ranch Bridge	09/09	1.3	0	25	25	0	0	0	0	3	0
Percent Change					+ 108						
Catherine Creek	09/02	2.0	3	28	31	3	0	1	0	8	0
Bridge below forks to	09/08	2.0	1	32	33	1	0	0	0	4	0
Highway Bridge	09/15	2.0	0	33	33	0	0	0	0	2	0
Percent Change					i-6						
South Fork Wenaha River[a]	09/07	6.0	8	38	46	8	0	1	0	7	0
Index area	09/16	6.0	0	48	48	0	0	0	0	5	0
Percent Change					+4						
Wenaha River[a]	09/07	3.0	4	12	16	4	0	0	0	6	0
Forks down 3 miles	09/16	3.0	0	18	18	0	0	0	0	2	0
Percent Change					+12						
Minam River											
Red's Bridge to	08/25	4.0	12	14	26	14	0	1	0	10	0
1 mile above the	09/04	4.0	9	38	47	11	0	3	0	30	0
Little Minam River	09/13	4.0	0	51	51	0	0	0	0	2	0
Percent Change					+96						

[a] *Only one supplemental survey conducted.*

Table 16. Percentage increase in spring chinook salmon redds observed in supplemental survey areas in some Imnaha and Grande Ronde basin streams, 1986-1993. Percent increase is from the index day count to the last supplemental survey.

Stream	Percent of redds observed in index area								
	1986	1987	1988	1989	1990	1991	1992	1993	Mean(95 % CI)
Imnaha Basin:									
Imnaha River	--	9	22	13	103	41	109	27	46.3(38.9)
Grande Ronde Basin:									
Hurricane Creek	120	56	900	1350	300	200	1400	108	554.3(478.7)
Lostine River	60	8	17	135	50	73	100	11	56.8(37.8)
Grande Ronde River	74	38	50	--	675	0	19	13	124.1(225.8)
Catherine Creek	28	13	8	50	29	11	28	6	21.6(12.5)
Minam River	--	21	22	26	39	100	7900	96	1172.0(277.1)
Wenaha River	--	--	--	--	--	29	12	7	16.0(28.7)

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APPENDIX A.

Spring Chinook Salmon Spawning Ground Survey Guidelines

General Spawning Ground Survey Instructions:

Surveys are to be conducted in a downstream direction as quickly and as efficiently as possible. Surveyors should wear polarized sunglasses and be equipped with appropriate wading gear (wading shoes or boots with felt or studded soles, walking staff). Surveyors should walk along the bank when possible in order to minimize harassment of spawning salmon. Redds should be approached from the side or downstream direction. Do not walk immediately above a redd as this may increase siltation. Do not step on redds or otherwise disturb (poke with a stick, mm over rocks) while conducting the survey.

On the <u>Spawning Ground Survey Form</u> fill out all the-header information before starting the survey. This information includes the following:

1. Stream surveyed.
2. Section surveyed. From - start of the section; To - end of the section. This information will be supplied to you at the start of the survey.
3. Date of survey (month/day/year).
4. Surveyor' s name.
5. Time start (Time end will be recorded at the end of the survey).
6. Water temperature.
7. River condition. Record visibility, flow conditions.
8. Survey type.

Redd counting procedures:

Count the number of redds observed in the survey section. Record redds as occupied or unoccupied.

Occupied = fish on or holding near a redd.
Unoccupied = no fish holding in the area of the redd.

Tally the number of redds observed in each category then write the number in each category and circle it. Use more than one data sheet if you run out of space.

Carcass sampling procedures:

1. Measure length of carcass.
    a. Fork length in mm.
    b. MEPS length in mm (mid-eye to hyplural plate).

2. Sex (cut open to be sure), for female carcasses determine the degree of spawning by examining the number of eggs retained in the body cavity and record percent spawned 0-25%, 26-50%, 51-75%, 75-100%).

3. Record any fin marks. Possible marks include Ad, RV, LV or any combination of the three marks. If the carcass is Ad clipped, cut the snout off (cut behind the eye) and place in a snout bag with a snout ID label. Record the snout ID number on the scale card.

4. Check for external and internal tags.

   External Tags
   a. Jaw tags.
   b. Disk tags.
   c. Dart tags.
   d. Put any external tags in a snout bag along with the scale card.

   Internal Tags
   a. Radio tags.
   b. VI visual implant tags (these were put on radio tagged fish).

5. On the Imnaha River surveys, all fish released above the weir are operculum punched, check both sides of the fish for punches and record the number of operculum punches and the location of punches (example, 2LOP, 3ROP).

6. Scale samples. Take 5-10 scales from the key scale area on each side of the fish (15 minimum scales). Locate the key scale area on the fish, scrape off all dirt and slime, using forceps- pluck out 5-10 scales from each side of the fish, place in scale envelope insert- <u>do not overlap scales.</u>

7. If you are in a supplemental count area, or immediately above, cut the tail completely off the fish to avoid repeat sampling.

Return the sampled carcass back into the river, but if the area will be surveyed again (supplemental area) place in a location where it will be highly visible and will not wash down into deep pools or log jams.